

# Chemotaxonomic Diversity of Herbal Leafy Vegetables in the Foot Hills of Eastern Himalayan Region, India

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## ABSTRACT

**Introduction:** Leafy vegetables are naturally available important constituent of Nutraceuticals, rich in several minerals, vitamins, crude fiber, antioxidants and active principles. The leafy vegetables, which are having miraculous healing properties of human ailments are considered as herbal leafy vegetables, most of which are utilized by herbal drug industry. Terai agro-ecological zone harbors a wide array of natural vegetation of which a considerable portion is consumed as a leafy vegetable by the inhabitants. Chemotaxonomic classification of medicinal plants now-a-days offers an additional advantage to the researchers over the binomial nomenclature as the chemical nature of secondary metabolites is also expressed along with the botanical name of the species which is having immense significance to the herbal drug develops.

**Objective:** The present study was aimed with an eye to develop an exhaustive chemotaxonomic database of the prevalent biodiversity of herbal leafy vegetables in the Terai region (foot hills of the eastern Himalayan region, India) of West Bengal.

**Method:** To understand the diversity of herbal leafy vegetables, sample village level survey was conducted in Cooch Behar and Jalpaiguri districts under the Terai region of West Bengal during 2011 and 2012. Information was collected through field observation and related taxonomic identification. The chemotaxonomic database of the observed herbal biodiversity was prepared through intensive literature survey.

**Result:** A total of 46 species of herbal leafy vegetables was observed in the prevalent biodiversity of this region. The plants and their potential medicinal properties along with their chemotaxonomic database were studied and summarized.

**Conclusion:** Traditionally the inhabitants used the herbal leafy vegetables for both as a vegetable and home herbal remedy. Forty six (46) major species of the existing flora of herbal leafy vegetables of the Terai region of West Bengal had been documented with their main chemical constituents through literature survey. This information would become valuable to the researchers and herbal drug industry.

**Keywords-** Herbal leafy vegetables, Biodiversity, Chemotaxonomic database.

## INTRODUCTION

Indian civilization possesses a rich ancient heritage of plant based health care system which was reflected in prehistoric literatures like Vedas (mentioned 129 medicinal plants), Kalpasutras (mentioned 519 medicinal plants of contemporary society)<sup>1</sup>, Charakasamhita and Sushrutasamhita etc. Being a biodiversity rich country India makes the home for 45000 different plant species out of which 3500 are medicinal while 1100 species are used in ISM and 650-700 species are used in herbal industries; yet only 150 species are used commercially<sup>2</sup>. Due to the recent upsurge of use of herbal formulations in the developed world for primary health care needs, the worldwide business volume of Phyto-pharmaceutical industries is poised nearly 70 billion USD as compared to 16.50 billion USD during late 90's with an annual growth rate of about 15-20% of European and 25-30% for North American market<sup>3</sup>. The global market for herbal plants would be 5 trillion USD by the end of 2050<sup>4</sup> which would become a potential money spinner for the biodiversity rich developing countries. Being a gene rich country, India harbors about 320 species of wild relatives of cultivated plants contributing a large section of the species gene pool. Indian herbal flora belongs to 2200 genera under 386 plant families<sup>5</sup> are largely trees (33%) followed by herbs (32%)<sup>6</sup>. Till date majority of medicinal plant species are collected from their natural habitat leading to depletion in the population causing a disturbance in the ecological balance. The problem is more acute where the roots are the economic plant part<sup>7</sup>. Nearly 80% of herbal raw materials worldwide are wild crafted and 20% from cultivated source chiefly from South American countries, the African Union, India, China and Pakistan<sup>3</sup>. Gangopadhyay (2007)<sup>8</sup> reported that out of 422000 species of flowering plants throughout the world,

52885 are medicinal in nature and 4160 species out of them are presently in threatened condition. Leafy vegetables are naturally available important constituent of Nutraceuticals, rich in several minerals, vitamins, crude fiber, antioxidants and active principles. Such vegetables, which are having miraculous healing properties of human ailments are considered as herbal leafy vegetables. The nutrient, minerals and vitamin content of some herbal leafy vegetables are presented in table -1<sup>9-12</sup>.

Northern part of West Bengal, comprising of six northern districts of the state namely-Maldah, Uttar Dinajpur, Dakshin Dinajpur, Darjeeling, Jalpaiguri and Coochbehar, popularly known as North Bengal possesses three distinct agro-climatic conditions explicitly Hill agro-climatic zone, Terai agro-climatic zone and Old Alluvial agro-climatic zone has the unique positional advantage of being in the juncture of three major phyto-geographical regions, namely the north east, the eastern peninsula and the eastern Himalaya with thick natural forest. Continuity and mixing of these three zones have created unique ethnobotanical diversity of cultivated and wild members of herbal species that are prevalent in these three regions. Owing to the natural location at the International boundary between the three different countries this region is in a high risk position for biopiracy-a significant menace for the natural wealth of India. Due to massive habitat destruction, overexploitation and environmental pollution in India, a number of species are subjected to threat on a regular basis, this region being no exception. The Terai Agro-climatic zone of the North Bengal region is endowed with fabulous biodiversity-a considerable portion of which is consumed by the inhabitants as leafy vegetables, which are uncommon to the southern counterpart of the state, some of which possess medicinal values also. Documentation of the indigenous knowledge through ethno-botanical study is important

for the conservation and utilization of biological resources<sup>13</sup>. Hence, it is very urgent to conserve, evaluate and characterize this valuable natural wealth of this region up to the ultimate extent. The Chemotaxonomic approach of classification of such biodiversity offers an additional advantage over the traditional binomial classification as the nature of secondary metabolites which have no apparent function in plants primary metabolism would be well versed which have immense potential to the herbal drug industries or herbal drug developers to generate new herbal formulations. The recent advances in plant genetic resources and intellectual property right (IPR) changes the outlook towards the unexplored herbal species, making the nation as the custodian as well as a major beneficiary of any development generated out of those species. However, the diversity and potential of herbal leafy vegetables of this region still becomes untapped and not thoroughly investigated for rational utilization. Considering the potential of leafy vegetables, sample village level survey was conducted to explore the diversity and traditional use of herbal leafy vegetables in this region. After collection of field level observations the data were processed further for documentation of herbal properties and secondary metabolites present in them. The diversity of secondary metabolites was observed through intensive literature survey. The present study was aimed with an eye to develop an exhaustive chemotaxonomic database of the prevalent biodiversity of herbal leafy vegetables in the Terai region of West Bengal.

## MATERIALS AND METHODS

The study was formulated to develop an exhaustive chemotaxonomic database of the existing biodiversity of herbal leafy vegetables in the Terai region of West Bengal, India. To understand the diversity of

herbal leafy vegetables, sample village level survey was conducted in Cooch Behar [88°47'44" - 89°54'35" East longitude and 25°57'47" - 26°36'2" North latitude ([http://coochbeharnic.in/HTMfiles/CoB\\_in\\_WB.html](http://coochbeharnic.in/HTMfiles/CoB_in_WB.html))] and Jalpaiguri [88°4' - 89°53' East longitude and 26°16' - 27°0' North latitude (<http://www.jalpaiguri.gov.in/html/disprof.html>)] districts during 2011 and 2012. The villages included - Dhalaguri, Haripur, Khagribari, Pundibari, Jatrapur, Raserkuthi, Dhangdhinguri, Konamalli, Satmile, Bararangras, Madhupur, Atialiguri, Kholta, Baneswar, Sakunibala, Okhrabari, Nishiganj, Barbisha, Kunjanagar, Jateshwar, Kamakhyaguri, Bhutnir Ghat, Salbari etc. Information was collected through participatory field observation and related taxonomic identification. More emphasis was given to the native people who were familiar with different herbal leafy vegetables. Initially the vernacular name and herbal properties of the prevalent leafy vegetables were collected. Afterwards the taxonomic positions, medicinal properties and the active principles of the observed herbal leafy vegetables of this region were tabulated through consultation with published and unpublished documents. The chemotaxonomic database of the observed herbal biodiversity was prepared through extensive literature survey.

## RESULTS AND DISCUSSION

Through participatory discussion and field observation forty six (46) different species of leafy vegetables, belonging to 42 genera distributed in 28 families were identified in the Terai agro-ecological zone of North Bengal which were having potential medicinal properties. The vernacular name, plant family, habitat, season of use and medicinal properties of those species were collected and presented in table-2. All the leafy vegetables have traditional medicinal use. The native people

rely on the herbal plants for the treatment of various ailments and disorders. The preferential use of herbal leafy species in remedial preparations may be due to their easy availability, inherent practice and quicker result. Use of *Amaranthus*, *Brassica*, *Centella* and *Chenopodium* as ethnomedicinal plants was observed among the inhabitants of Shivalik Hills of Himachal Pradesh, India<sup>14</sup>. *Allium cepa*, *Azadirachta indica* and *Corchorus* sp. were also successfully utilized as ethnomedicinal plants by the Idoma people of Nigeria<sup>15</sup>. However, the knowledge is restricted to the older people and most of the young people are indifferent about the medicinal and healing properties of the herbal leafy vegetables. This could be due to easy accessibility of medical facilities in nearby hospitals. The valuable indigenous traditional knowledge of herbal healing is going into oblivion very fast. Efforts are required to conserve the traditional knowledge for the future generations through inculcating awareness, publicity and documentation. The scientific basis of health benefit with herbal leafy vegetables can be well understood if the active principles or the bioactive compounds present in the plants are identified. In the present work, the different active principles of the selected herbal leafy vegetables were collected and presented in Table- 3. Most of the herbal leafy vegetables contain multiple phytochemicals having a potential for the health benefit of the human body. Most of green herbal leafy vegetables have been identified to exhibit antioxidant activities. They have different antioxidants such as vitamin C, vitamin E, carotenes, lycopenes, polyphenols and other phytochemicals<sup>16</sup>. In recent years, renewed awareness has been generated among the consumer regarding the relationship between diet and health. Credible scientific research indicates potential health benefit and disease-risk reduction attributes of the phytochemicals

present in the herbal leafy vegetables<sup>17-20</sup>. It has increased the demand for information on beneficial components of different active principles present in the plant. However the vast potential of the active principles of different leafy vegetables cannot be achieved without understanding the mechanisms of action to ensure the safety and efficacy of the chemicals. Additional research in this direction will be of immense helpful for wider use of these traditional natural resources for cheaper and effective plant remedies for human ailments.

## CONCLUSION

Terai agro-ecological zone is endowed with favorable climatic condition for the growth of diverse herbal leafy vegetables. Chemotaxonomic classification of those biodiversity now-a-days offers an additional advantage as the chemical nature of secondary metabolites is also expressed which is having immense significance to the herbal drug develops. Traditionally the inhabitants use those for both as vegetable and home herbal remedy. 46 major species of the existing flora of herbal leafy vegetables of the Terai region of West Bengal used by the villagers have been documented with their main chemical constituents through literature survey. This information would become valuable to the researchers and herbal drug industry.

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**Table 1.** Nutritional value of some common herbal leafy vegetables

Crop	Energy (kcal)	Mois-ture (g)	Pro-tein (g)	Fat (g)	CHO (g)	Reti-nol (iu)	Thia-min (mg)	Ribo-flavin (mg)	Niacin (mg)	Ascorbic acid (mg)	Ca (mg)	P (mg)	Fe (mg)
Amaranth	45	87.7	4.0	0.5	6.1	9108	0.03	0.30	1.20	99	397	83	25.5
Basella	32	90.8	2.8	0.4	4.2	12276	0.03	0.16	0.50	87	200	35	10.5
Bottle gourd leaves	39	87.9	2.3	0.7	6.1	-	-	-	-	-	-	-	-
Chinese cabbage	14	95.0	1.2	0.1	3.0	150	0.05	0.04	0.60	25	43	40	0.6
Chow chow leaves	27	92.5	0.7	0.1	5.7	0	0	0.04	0.40	4	140	30	0.6
Cowpea leaves	38	89.0	3.4	0.7	4.1	10019	0.05	0.08	0.60	4	290	58	20.1
Drumstick leaves	92	75.9	6.7	1.7	12.5	11187	0.06	0.05	0.80	220	440	70	7
Fenugreek leaves	49	86.1	4.4	0.9	6.0	3861	0.04	0.31	0.80	52	395	51	16.5
Pumpkin leaves	57	81.9	4.4	0.8	7.9	3173	-	-	-	10	392	112	2.1
Taro leaf stalk	24	93.0	0.5	0.2	6.0	594	0.02	0.04	0.40	13	49	25	0.9
Water spinach	28	90.3	2.9	0.4	3.1	3267	0.05	0.13	0.60	37	110	46	3.9

**Table 2.** Identified herbal leafy vegetables in the Terai agro-ecological zone of West Bengal

Verna- cular name	Botanical name	Plant family	Habitat	Seasonality	Medicinal properties
Alu-sak	<i>Solanum tuberosum</i> L.	Solanaceae	Terrestrial	Winter	Purgative
Amrul	<i>Oxalis corniculata</i> Linn.	Oxalidaceae	Terrestrial	Rainy	Cold and cough, loss of appetite, dysentery
Bathua	<i>Chenopodium album</i> Linn.	Chenopodiaceae	Terrestrial	Winter and Spring	Deworming, Piles
Brahmi-sak	<i>Bacopa monnieri</i> (L.) Pennell.	Scrophulariaceae	Terrestrial	Throughout the year	Brain tonic. Soothing effect
Chola-sak	<i>Cicer arietinum</i> Linn.	Leguminosae	Terrestrial	Winter	Digestive, bowel clearance, purgative, astringent,
Chow-chow-sak	<i>Sechium edule</i> Jacq. Sw.	Cucurbitaceae	Terrestrial	Throughout the year	Diuretic, cardiovascular and Anti-inflammatory
Dhane-pata	<i>Coriandrum sativum</i> Linn.	Umbelliferae	Terrestrial	Winter	Gas and acidity, problem of bile's, fever, antioxidant
Dhemchi	<i>Fagopyrum esculentum</i> Moench.	Polygonaceae	Terrestrial	Winter and Spring	Improve blood flow, prevent atherosclerosis
Dhenki-sak	<i>Diplazium esculentum</i> Retz. Sw.	Athyriaceae	Terrestrial	Throughout the year	Antioxidant, tonic
Gandal-pata	<i>Paederia foetida</i> L.	Rubiaceae	Terrestrial	Spring, Summer, Rainy	Laxative, bowel-function regulator
Gima-sak	<i>Glinus oppositifolius</i> (L.) A. DC.	Molluginaceae	Terrestrial	Spring, Summer, Rainy	Liver complaints, stomachic, aperients and antiseptic
Helencha-sak	<i>Enhydra fluctuans</i> Lour.	Asteraceae	Semi-aquatic herb	Winter, Spring	Skin disease, analgesic, appetizer, anti-inflammatory
Kachu-sak	<i>Colocasia esculenta</i> (L.) Schott	Araceae	Terrestrial	Summer, Rainy	Laxative, urinary trouble,
Kalmi-sak	<i>Ipomoea reptans</i> Linn.	Convolvulaceae	Aquatic / Terrestrial	Spring, Summer, Rainy	Laxative, insect sting, boils
Kanta-nate	<i>Amaranthus spinosus</i> Linn.	Amaranthaceae	Terrestrial	Spring, Summer, Rainy	Female disease, Hemorrhage from the liver
Kharkol	<i>Typhonium trilobatum</i> (L.) Schott	Araceae	Terrestrial	Spring, Summer, Rainy	Muscular pain, antiinflammatory, tumours, anti-diarrheal
Khesari	<i>Lathyrus sativus</i> Linn.	Leguminosae	Terrestrial	Winter	Constipation, joint

Verna- cular name	Botanical name	Plant family	Habitat	Seasonality	Medicinal properties
					pain
Kulekhara	<i>Asteracantha longifolia</i> (L). Nees	Acanthaceae	Terrestrial	Throughout the year	Anemia, diuretic
Kumra-sak	<i>Cucurbita moschata</i> (Duchesne ) ex Poir.	Cucurbitaceae	Terrestrial	Throughout the year	Prevent premature aging, reduce weight, skin and teeth benefit
Laffa	<i>Malva verticillata</i>	Malvaceae	Terrestrial	Winter	Whooping cough. skin disease. demulcent, digestive, diuretic, emollient
Lau-sak	<i>Lagenaria vulgaris</i> Seringe.	Cucurbutaceae	Terrestrial	Throughout the year	Digestive complaints, dental problems
Lunia	<i>Portulaca oleracea</i> Linn. / <i>P.</i> <i>quadrifida</i> Linn.	Portulaceae	Terrestrial	Rainy	Cough, headache, increase digestive power, Stammering
Maan	<i>Alocasia indica</i> Schott.	Araceae	Terrestrial	Throughout the year	Laxative, digestive, piles
Matar-sak	<i>Pisum sativum</i> Linn.	Leguminosae	Terrestrial	Winter	Increase appetite, bowel clearance, hemorrhage, cough
Methi-sak	<i>Trigonella foenum-graecum</i> L.	Leguminosae	Terrestrial	Winter	Digestive problem, constipation, loss of appetite
Mula -sak	<i>Raphanus sativus</i> Linn.	Cruciferae	Terrestrial	Winter	Calculi, increase appetite, promotes urination
Nate-sak	<i>Amaranthus tricolor</i> / <i>A.</i> <i>viridis</i> / <i>A. tenuifolia</i>	Amaranthaceae	Terrestrial	Spring, Summer, Rainy	Piles, cough, digestive, bowel clearance
Neem-pata	<i>Azadirachta indica</i> A. Juss.	Meliaceae	Terrestrial	Throughout the year	Panacea
Ool-sak	<i>Amorphophallus campanulatus</i> (Roxb) Bl.	Araceae	Terrestrial	Summer, Rainy	Piles, rheumatism, cough, body pain, insect sting
Palang-sak	<i>Beta vulgaris</i> var. <i>bengalensis</i>	Chenopodiaceae	Terrestrial	Winter	Headache, bowel clearance, blood purifier
Palta-pata	<i>Trichosanthes dioica</i> Roxb.	Cucurbitaceae	Terrestrial	Spring, Summer, Rainy	Digestive complaints, hypocholesterolemic, hypoglyceridimic, hypophospholipemic
Pat-sak	<i>Corchorus capsularis</i> Linn.	Tiliaceae	Terrestrial	Spring, Summer	Constipation, blood dysentery
Piring	<i>Trigonella corniculata</i> Linn.	Leguminosae	Terrestrial	Spring, Summer, Rainy	Urinary problem, acidity



Verna- cular name	Botanical name	Plant family	Habitat	Seasonality	Medicinal properties
Piyaj-sak	<i>Allium cepa</i> Linn.	Liliaceae	Terrestrial	Winter	Running nose, bowel clearance
Lal Poi	<i>Basella rubra</i> Linn.	Basellaceae	Terrestrial	Throughout the year	Bleeding, piles, pyorrhoea, tumour
Pudina	<i>Mentha arvensis</i> var. <i>piperescence</i>	Lamiaceae	Terrestrial	Spring, Summer, Rainy	Loss of appetite, flatulency, gas and acidity
Punarnaba	<i>Boerhaavia diffusa</i> Linn.	Nyctaginaceae	Terrestrial	Spring, Summer, Rainy	Chronic cough, calculi, insomnia, urticaria, fever,
Rai-sak	<i>Brassica rapa</i> L.	Cruciferae	Terrestrial	Winter	Rheumatism, leprosy, skin disease
Sada Poi	<i>Basella alba</i> Linn.	Basellaceae	Terrestrial	Throughout the year	Piles, tumour, urticaria, piorrhoea
Sajina-sak	<i>Moringa oleifera</i> Lam.	Moriangaceae	Terrestrial	Spring, Summer, Rainy	Cold and cough, deworming
Salinche	<i>Alternanthera sessilis</i> (R.) Br.	Amaranthaceae	Terrestrial	Spring, Summer, Rainy	Loss of appetite, gas, cough, deworming
Sapla	<i>Nymphaea alba</i> Linn.	Nymphaeaceae	Aquatic	Throughout the year	Hemorrhage from the stomach, dysentery, Loss of appetite
Sarse-sak	<i>Brassica campestris</i> / <i>B. juncea</i> / <i>B. napus</i>	Cruciferae	Terrestrial	Winter	Rheumatism, leprosy, skin disease
Sushni-sak	<i>Marsilea quadrifolia</i> Linn.	Marsileaceae	Aquatic / Semi-aquatic	Spring, Summer, Rainy	Loss of appetite, stomach complaints, Insomnia, epilepsy
Tak-palang	<i>Rumex</i> sp.	Polygonaceae	Terrestrial	Summer, Rainy	Promotes urination, gas, vomiting tendency
Thankuni	<i>Centella asiatica</i> (Linn.) Urban	Umbelliferae	Terrestrial / Semi-aquatic	Throughout the year	Dysentery sometimes replaces Brahmi



**Table 3.** Active principles of the observed herbal leafy vegetables

Name*	Active principles
Alu-sak	Potassium, sulfur, phosphorus, chloride, solanine and solasodine
Amrul	Vitamin C
Bathua	Phenolic amide, N-trans- feruloyl-4-O-methyl-dopamine
Brahmi-sak	Bacosides
Chola-sak	Amino acids, ascorbic acid, beta-carotene, iron
Chow-chow-sak	Amino acids, Vitamin C
Dhane-pata	Psoralen, angelicin, scopoletin, umbelliferone (Coumarins), Quercetin-3-glucuronide, Isoquercitrin, coriandrinol ( $\beta$ -sitosterol-d-glucoside), and rutin (Flavonoids), Chlorogenic and caffeic acids (Organic acids)
Dhemchi	Rutin, flavonol glycoside quercetin-3-O-rutinosid
Dhenki-sak	Beta-carotene: low; vitamin E: medium; riboflavin: low; ascorbic acid: low; calcium: low; iron: low; protein: 3.2%, antioxidative activities higher than alpha-tocopherol.
Gandal-pata	Paederoside, Asperuloside, Scandoside (Glycoside), Paederine A and B (Alkaloid) Ursolic acid, oleanolic acid, arachidic acid (Organic Acid)
Gima-sak	Spergulagenin A, Spergulagenic acid
Helencha-sak	Baicalein 7-O-glucoside and Baicalein 7-O-diglucoside, Enhydrin, Fluctuanin and Fluctuandin
Kachu-sak	Thiamin, riboflavin, iron, phosphorus and zinc, vitamin B6, vitamin C, niacin, potassium, copper and manganese
Kalmi-sak	Vitamin A, B, C, E, and "U" (S-methyl-methionine) aliphatic pyrrolidine amides, carotenoids, hentriacontane, $\beta$ -sitosterol, Prostaglandin, leukotrine, N-trans- and N-cis feruloyltyramines
Kanta-nate	7-p-coumaroyl apigenin 4-O-beta-D-glucopyranoside, a new coumaroyl flavone glycoside called spinoside, xylofuranosyl uracil, beta-D-ribofuranosyl adenine, betasitosterol glucoside, hydroxycinnamates, quercetin and kaempferol glycosides, betalains; betaxanthin, betacyanin, amaranthine and isoamaranthine, gomphrenin, betanin, $\beta$ -sitosterol, stigmasterol, linoleic acid, 0.15% rutin and beta-carotene
Kharkol	$\beta$ -sitosterol
Khesari	Vitamin A, B-complex, phenols
Kulekhara	7-O-B-D-glucopyranosyl-dihydroquercetin-3-O-a-D-glucopyranoside (Antioxidant), iron, potassium
Kumra-sak	Carbohydrate 42%, protein 40% (Amino acid score - 68), Fat 18%, Vit A – 1136 IU, leutin, xanthin and carotenes, antioxidant
Laffa	Mucilage, polysaccharides, flavonoids and anthocyanidins, $\beta$ -sitosterol
Lau-sak	4-C-glycosylflavone: 7-O-glucosyl-6-C-glucoside apigenin, 6-C-glucoside apigenin, 6-C-glucoside luteolin, and 7,4'-O-diglucosyl-6-C-glucoside apigenin (Flavonoids)
Lunia	Linolenic acid (omega-3), magnesium
Maan	Alocasin, flavonoids and glycosides
Matar-sak	Thiamine, riboflavin, niacin, L-asparagine
Methi-sak	Trimethylamine, Neurin, Trigonelline, Choline, Gentianine, Carpaine and Betain (Alkaloid), Isoleucine, 4-Hydroxyisoleucine, Histidine, Leucine, lysine, L-tryptophan, Argenine (Amino Acids), Quercetin, rutin, vetixin isovetixin (Flavonoids)
Mula-sak	Thiocyanate
Nate-sak	Carotenoid, folate, methionine, anthocyanine
Neem-pata	Azadirachtin and nimbidin

Name*	Active principles
Ool-sak	Amblyone (Triterpenoid), Betulinic acid (Organic Acid), Stigmasterol, $\beta$ -sitosterol (Phytosterols)
Palang-sak	vitamin A (and especially high in lutein), vitamin C, vitamin E, vitamin K, Polyglutamyl folate (vitamin B <sub>9</sub> or folic acid), magnesium, Cystine, manganese, folate, betaine, iron, vitamin B <sub>2</sub> , calcium, potassium, vitamin B <sub>6</sub> , folic acid, copper, protein, phosphorus, zinc, niacin, selenium and omega-3 fatty acids, rubiscolins
Palta-pata	2,4 $\alpha$ -Ethylcholest-7-enol & 2,4 $\beta$ -Ethylcholest-7-enol (Phytosterols)
Pat-sak	Calcium, Vitamin C, Corchoroside A, $\alpha$ -tocopherol and chlorogenic acid
Piring	Triacontane and 22,23-dihydrostigmasterol,
Piyaj-sak	1-o-caffeoyl-beta-d-glucose,1-o-feruloyl-beta-d-glucose,1-o-p-coumaroyl-beta-d-glucose, methyl-propenyl-trisulfide, methyl-cis-propenyl-disulfide
Poi	Proteins, fat, vitamin A, vitamin C,vitamin E, vitamin K, vitamin B <sub>9</sub> (folic acid), riboflavin, niacin, thiamine and minerals such as calcium, magnesium and iron. Kaempherol flavonoid
Pudina	Menthol, menthone, 1,8-cineole, methyl acetate
Punarnaba	Punarnavine (Alkaloid), Punernavoside (Glycoside), Boeravinones (Rotenoids), Borhavine (Xanthone), Ursolic acid (Organic acid)
Rai-sak	Vitamin A, D, B <sub>12</sub> , calcium, Isothiocyanates
Sajina-sak	Niazirin, Niazirinin (Glycoside), Quercetin (Flavonoid)
Salinche	$\beta$ -carotene, ricinoleic, myristic, palmitic, stearic, oleic, linoleic and uronic acid, $\beta$ -sitosterol, Lutein
Sapla	Galacturonic acid and raffinose
Sarse-sak	Glucosinolates, kampferol and quercetin (Flavonoids)
Sushni-sak	Marsilin (1-triacontanol-cerotate), 3-hydroxy-tri-acontan-11-one,hentriacontan-6-ol, methylamine, beta-sitosterol, marsileagenin A, flavonol-O-mono-and-diglycoside, C-glucoylflavones and C-glucosylxanthenes
Tak palang	Organic acids, Tocopherols, ascorbic acid



Name*	Active principles
Thankuni	Asiaticosides, rahmoside and brahminoside, Isothankuniside and thankuniside, Centelloside (Saponin / triterpenoid), Hydrochotine (Alkaloid)

\*Botanical names of the leafy vegetables are given in Table 2.

